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Influence of Cowpea Crop on Yield of Corn

University of Tennessee Agricultural Experiment Station

C. A. Mooers

THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION
Knoxville

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2. Effects of Cowpeas and Soybeans Planted with Corn

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INFLUENCE OF COWPEA CROP ON YIELD OF CORN

1. Experiments in a Cowpea-Corn Rotation
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INTRODUCTION

In a study of the influence of the cowpea crop on soil productivity, both winter and summer crops following require consideration. Wheat or other small grain can be planted in the fall to measure the effect of the summer's cowpea crop, as was done in the cowpea-wheat experiments described in Bulletin 135. The present publication has to do primarily with the effects of the cowpea crop on the corn crop of the following year. In addition, data are given showing the effects of planting either cowpeas or soybeans with the corn, as is not infrequently done in farm practice.

1. EXPERIMENTS IN A COWPEA-CORN ROTATION

ON GRAVELLY DOLOMITE SOIL

Field experiments in which cowpeas were grown one year and corn the next were carried out continuously at the Knoxville Station for 20 years—1905-1924—10 crops of each kind being obtained. The soil used was a gravelly loam derived from the dolomite formation, and was a good representative of a prominent soil type of East Tennessee.

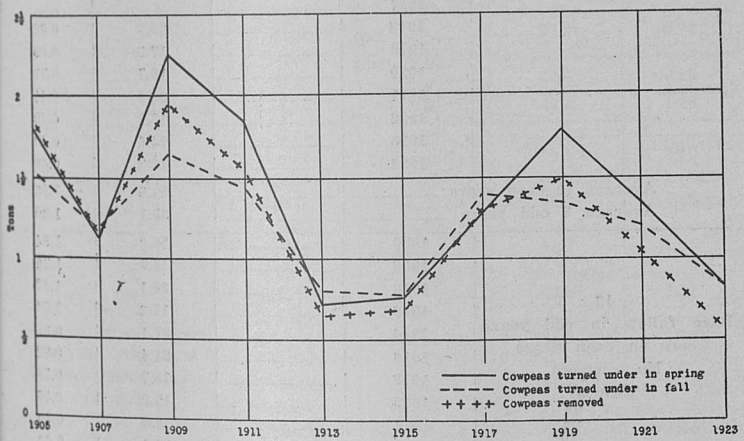

Chart 1—Yields of cowpea hay in cowpea-corn rotation—Knoxville

The soil was in a good state of productivity at the outset, but was not well enough supplied with plant food—nitrogen, in particular—to maintain high yields without manuring. Like applications of acid phosphate and muriate of potash were made under each of the experimental conditions, in order that the nitrogen supply might be the limiting factor so far as plant food was concerned.

Diagram 1 shows the divisions of the experimental range and the cropping system, which included continuous corn, corn after bare fallow, corn after cowpeas removed as hay, corn after cowpeas turned under in the fall, and corn after cowpeas left on the ground through the winter and turned under in the spring. The range was less than 100 feet from the cowpea-wheat experiment reported in Bulletin 135, but lay on a higher slope, where the soil was appreciably lighter in color, more gravelly, and less well supplied with nitrogen and humus.

TABLE 1—*Yields per acre of cowpea hay and of corn for the 20-year period* 1905-1924—*fertilizer treatments the same under all conditions*

Plot Crop Disposition of cowpeas	Year	Cowpea hay	Corn	
			Grain	Stover
		Tons	Bu.	Tons
	1906		49.4	1.80
	1907		58.9	2.00
	1908		41.0	1.10
	1909		52.7	1.70
	1910		45.5	1.44
	1911		45.2	1.60
	1912		16.1	1.51
10, 11	1913		24.6	1.02
Continuous corn	1914		35.8	1.01
No cowpeas	1915		27.9	1.20
grown	1916		27.9	1.11
	1917		.....	.....
	1918		23.2	0.66
	1919		17.3	0.89
	1920		18.7	0.76
	1921		23.6	0.41
	1922		13.2	0.49
	1923		14.6	0.49
	1924		18.2	0.49
Average 10 even years			28.6	1.05
Average 8 odd years			33.1	1.20
	1906		58.9	1.84
	1908		43.7	1.20
	1910		35.1	1.23
13	1912		17.2	1.54
Bare fallow in odd years,	1914		37.1	0.93
corn in even years	1916		21.4	0.82
No cowpeas	1918		15.7	0.53
grown	1920		19.9	0.56
	1922		8.6	0.40
	1924		13.6	0.40
Average 10 years			27.1	0.96

TABLE 1—(*Concluded*)

Plot Crop Disposition of cowpeas	Year	Cowpea hay	Corn	
			Grain	Stover
		Tons	Bu.	Tons
	1905	1.86	.....	.....
	1906	.....	53.9	1.92
	1907	1.15	.....	.....
	1908	.....	40.9	1.32
	1909	1.94	.....	.....
	1910	.....	43.4	1.45
	1911	1.55	.....	.....
	1912	.....	20.7	1.73
14, 15	1913	0.65	.....	.....
Cowpeas in odd years,	1914	.....	39.7	1.09
corn in even years	1915	0.68	.....	.....
Cowpeas removed	1916	.....	36.5	1.19
as hay	1917	1.31	.....	.....
	1918	.....	30.7	1.06
	1919	1.49	.....	.....
	1920	.....	26.7	1.01
	1921	1.03	.....	.....
	1922	.....	18.9	0.52
	1923	0.57	.....	.....
	1924	.....	28.8	0.66
Average 10 years.....		1.22	34.0	1.20
	1905	1.81	.....	.....
	1906	.....	58.7	1.95
	1907	1.12	.....	.....
	1908	.....	50.2	1.40
	1909	2.26	.....	.....
	1910	.....	57.1	1.71
	1911	1.87	.....	.....
	1912	.....	33.2	1.93
16, 17	1913	0.72	.....	.....
Cowpeas in odd years,	1914	.....	44.7	1.25
corn in even years	1915	0.76	.....	.....
Cowpeas turned under	1916	.....	39.5	1.38
in spring	1917	1.28	.....	.....
	1918	.....	34.3	1.28
	1919	1.79	.....	.....
	1920	.....	40.1	1.20
	1921	1.35	.....	.....
	1922	.....	27.2	0.72
	1923	0.83	.....	.....
	1924	.....	39.3	0.93
Average 10 years.....		1.36	42.4	1.38
	1905	1.54	.....	.....
	1906	.....	70.1	2.10
	1907	1.18	.....	.....
	1908	.....	43.3	1.32
	1909	1.66	.....	.....
	1910	.....	51.7	1.64
	1911	1.44	.....	.....
	1912	.....	35.0	1.91
18, 19	1913	0.81	.....	.....
Cowpeas in odd years,	1914	.....	46.6	1.03
corn in even years	1915	0.78	.....	.....
Cowpeas turned under	1916	.....	41.7	1.49
in fall	1917	1.40	.....	.....
	1918	.....	27.2	1.21
	1919	1.35	.....	.....

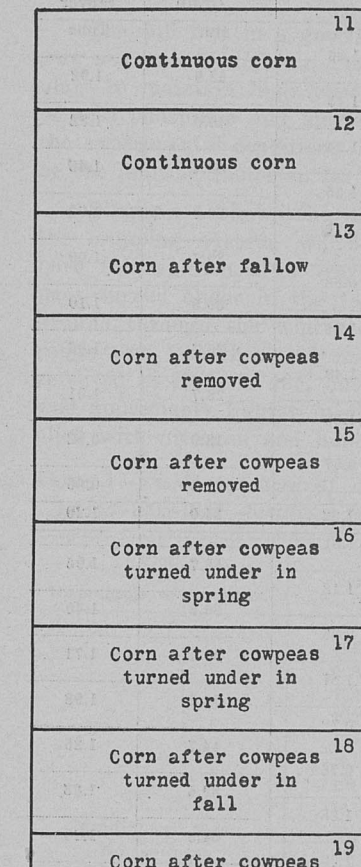

Diagram 1.—Experimental range in cowpea-corn rotation—each plot 1/40 acre—Knoxville Station

DISCUSSION OF THE DATA

Table 1 gives the yields both cowpea hay and of corn u the various conditions. Chart shows the yields of cowpea h and chart 2 the yields of c as obtained in the 20 years. T hay yields were only slig greater where the crops were t ed under than where removed—t averages being 1.22 tons per a on plots 14 and 15, where t crops were removed; 1.36 tons plots 16 and 17, where the c were turned under in the spri and 1.27 tons on plots 18 and 1 where the crops were turned un in the fall. In all cases there w a considerable amount of fal leaves which could not be inclu in the yields.

The records show a similarity the yields of cowpea hay under the experimental conditions, w the tendency toward decrease yields; but it is evident that t nature of the season played very important part, so that more definite conclusion is hard warranted.

The yields of corn as depicte in chart 2 show a decided fall off under all conditions throughou the period. As might be expecte the yields are best where the cow pea crops were turned under, t average for the 4 plots 16 to 1 being 41.5 bushels per acre. The average for plots 14 and 1 where the cowpea crops were removed, was 34.0 bushels. The a erage for plots 10 and 11, where corn was grown continuously, w 28.6 bushels for the 10 even years, when corn was grown on a plots. Where a bare fallow was maintained, in the years when cow peas were grown elsewhere, as indicated, the average yield of co was 27.1 bushels per acre, or 1.5 bushels less than that for the sa years under continuous corn.

Inspection of chart 2 shows that for the first 6 crops the yi of corn following cowpeas turned under in the fall was not materia different, on the average, from that obtained where the cowpe plants lay on top of the ground through the winter. On the other hand, the last 4 crops were in favor of the latter practice by an a erage of 6 bushels per acre. It is not unreasonable to assum

that the fall plowing hastened the decomposition of the cowpea plants, and resulted in a greater loss of nitrogen by leaching than was the case under the other condition. The failure of the first 6 crops to show a definite difference may be attributed to the more fertile condition of the soil in the earlier years, when the limiting factor was moisture supply rather than nitrogen.

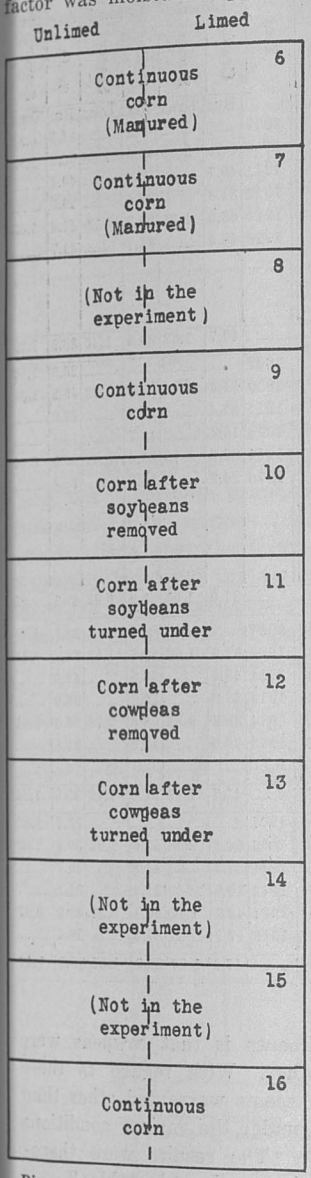

Diagram 2—Experimental range in summer legume-corn rotation—each plot 1/40 acre—Knox County

It is of interest to note that the yields of the first 5 corn crops from plots 14 and 15, where the cowpea hay was removed, were little different from those obtained in the same years from plots 10 and 11, where corn was grown continuously. For each of the last 5 years, however, the yields were decidedly in favor of plots 14 and 15; their average yield being greater by 8.1 bushels of corn per acre. Similarly, the evidence for the last 5 corn crops was favorable to continuous cropping in corn rather than to alternation with bare fallow, which was included for experimental purposes and not because of its possible practical value.

ON CHICKAMAUGA LIMESTONE SOIL

Similar experiments to those at the Knoxville Station were carried out for 12 years—1906-1917—on a rather heavy type of soil derived from the decomposition of the Chickamauga, or "rotten," limestone. This soil was grayish when dry, but of a light brown color when wet. The subsoil was heavy and of a yellowish-red color. Both the soil and subsoil were appreciably heavier and less granular than those at the Experiment Station.

These experiments differ from those at Knoxville in two important particulars; first that data are available for both limed and unlimed conditions, and, secondly, that comparative data were obtained from light applications of farmyard manure.

TABLE 2—*Yields per acre of legume (cowpea and soybean) hay and corn under various experimental conditions—experiments conducted in Knox County on heavy silt loam derived from Chickamauga limestone*

Plot Crop Disposition of legume	Manure and fertilizer	Legume hay				Corn						
							Limed		Unlimed		Average	
		Year	Limed	Unlimed	Average	Year	Grain	Stover	Grain	Stover	Grain	Stover
			Tons	Tons	Tons		Bu.	Tons	Bu.	Tons	Bu.	Tons
6, 7 Continuous corn No legume	6 tons manure per acre every 2 years, beginning 1906 —30 tons in all					1907	.....	.....	.....	.....	14.5	.....
						1909	64.9	2.08	55.0	1.90	60.0	1.99
						1911	45.7	.....	35.0	.....	40.4	.....
						1913	31.4	.....	27.5	.....	29.5	.....
						1914	43.0	1.16	39.7	0.89	41.4	1.03
						1916	48.3	.....	35.1	.....	41.7	.....
	Average						46.7	1.62	38.5	1.40	38.0	1.51
9, 16 Continuous corn No legume	200 lbs. phosphate, 25 lbs. potash per acre every 2 years, beginning 1906					1907	.....	.....	.....	.....	22.8	.....
						1909	51.4	1.44	45.0	1.32	48.2	1.38
						1911	31.4	.....	26.9	.....	29.2	.....
						1913	15.4	.....	12.7	.....	14.1	.....
						1914	32.5	0.70	26.4	0.57	29.5	0.64
						1916	24.2	.....	13.3	.....	18.8	.....
	Average						31.0	1.07	24.9	0.95	27.1	1.01
10, 12 Soybeans on plot 10, cowpeas on plot 12 Removed as hay	Phosphate and potash as for plots 9 and 16	1906	.....	.....	1.59	1907	.....	.....	.....	.....	23.7	.....
		1908	.....	.....	1.42	1909	57.9	1.50	53.6	1.51	55.8	1.51
		1910	1.11	0.60	0.86	1911	48.4	.....	36.8	.....	42.6	.....
		1912	1.37	0.75	1.06	1913	25.3	.....	20.7	.....	23.0	.....
		1915	1.24	0.90	1.07	1914	38.2	0.88	33.8	0.73	36.0	0.81
		1917	1.22	0.89	1.06	1916	38.6	.....	25.0	.....	31.8	.....
	Average		1.24	0.79	1.18	.....	41.7	1.19	34.0	1.12	35.5	1.16
11, 13 Soybeans on plot 11, cowpeas on plot 13 Turned under	Phosphate and potash as for plots 9 and 16	1906	.....	.....	1.59	1907	.....	.....	.....	.....	25.7	.....
		1908	.....	.....	1.58	1909	64.5	2.08	53.6	1.92	59.1	2.00
		1910	1.08	0.61	0.85	1911	57.1	.....	41.8	.....	49.5	.....
		1912	1.43	0.71	1.07	1913	26.9	.....	21.4	.....	24.2	.....
		1915	1.28	0.93	1.11	1914	43.9	1.11	36.1	0.82	40.0	0.97
		1917	1.30	0.84	1.07	1916	47.2	.....	31.5	.....	39.4	.....
	Average		1.27	0.77	1.21	.....	47.9	1.60	36.9	1.37	39.7	1.49

Another difference in these experiments is that cowpeas were used in one set and soybeans in another. With regard to these summer legumes no material conclusion seems warranted other than that their behavior was much the same under the various conditions and their effects on corn were similar. The results were therefore averaged, and the data so obtained are given in table 2.

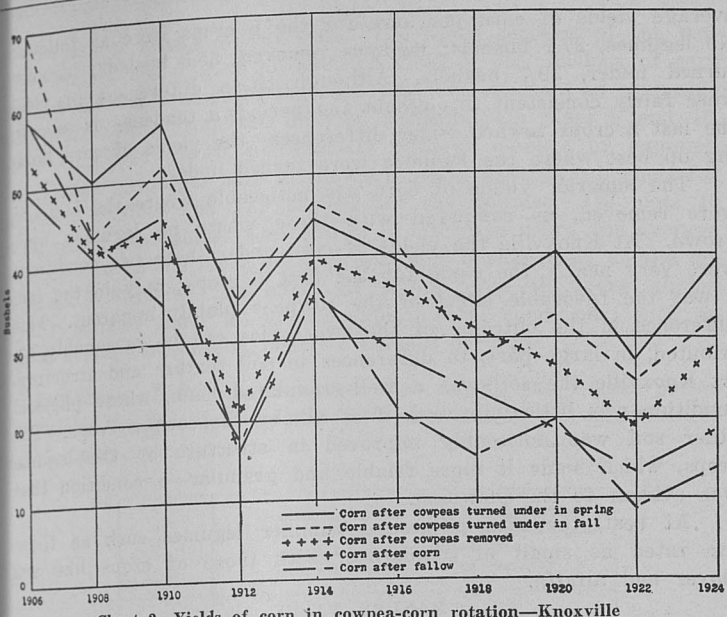

Chart 2—Yields of corn in cowpea-corn rotation—Knoxville

DISCUSSION OF THE DATA

EFFECTS OF THE LEGUMES ON THE CORN CROPS

Chart 3 presents graphically the yields of the 6 corn crops as influenced by the various conditions. It is evident, above all other considerations, that the legumes, whether removed or turned under, materially increased the yields of corn. Where they were removed the yields were intermediate between those obtained where no legume was grown and where the legumes were turned under. The

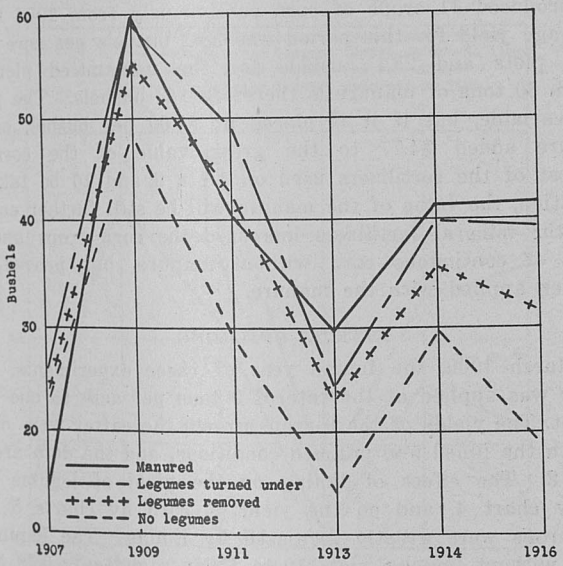

Chart 3—Yields of corn under various conditions—limed and unlimed sections averaged—Knox County

average yields of corn per acre for the 6 crops were as follo
No legumes, 27.1 bushels; legumes removed, 35.5 bushels; legu
turned under, 39.7 bushels. Although these differences in y
were fairly consistent throughout the period, a tendency is see
the last 2 crops toward wider differences—the yields of corn h
ing up best where the legumes were turned under.

The superior yields of corn are noticeable where the legu
were removed, as compared with those where no legumes w
grown. At Knoxville the yields of corn under these two conditi
were very nearly the same for the first 5 crops; only in the l
5 was the favorable effect of the cowpeas plainly apparent. T
difference in the outcome of the two series can be reasonably a
tributed, in large part, to differences in soil texture and structu
At Knoxville the soil was a well-granulated loam, whose physi
condition was little improved, if at all, by the cowpea crops. T
other soil was noticeably improved in structure by the legu
crops, which made it more friable and granular—a condition th
was evident to the plowman.

At best, the after-effects of summer legumes such as the
are rated as small in comparison with those of crops like re
clover and alfalfa.

MANURE VALUE

Two plots, Nos. 6 and 7, were manured at the rate of 6 to
per acre once in 2 years, or 30 tons for the 12 years, and co
grown continuously. The yields, as obtained in the corn years f
the other plots, are given in table 2. Chart 3 shows that the yiel
were similar to those where the legumes were turned under, th
latter having a slightly better average by 1.7 bushels per acr

A more definite idea of the money value of the manure may b
gained by comparing the yields obtained from the manured plo
6 and 7 with those from the unmanured plots 9 and 16, both se
having produced 11 crops of corn continuously from 1906 to 191
The average yield for this period was 38.1 bushels per acre for th
manured plots and 25.1 bushels for the unmanured plots. The
gain from 30 tons of manure is therefore 143 bushels. The price
corn is variable, but if it is placed at $1.00 per bushel, each to
of manure added $4.77 to the gross value of the corn cro
If the cost of the fertilizers used on plots 9 and 16 be taken int
consideration, the value of the manure will be still further enhance
because the mineral fertilizers increased the corn crops under th
condition of continuous corn without manure, but proved of n
value when applied with the manure.

EFFECTS OF LIMING

In March 1909, the fourth year of these experiments, grou
limestone was applied at the rate of 2 tons per acre to one half o
every plot. The yields of the 9 crops grown thereafter were obtain
under both the limed and unlimed conditions, and the data are giv
in table 2. The effect of liming on the yield of legume hay i
shown by chart 4, and on the yield of corn by charts 5 and

All crops were greatly increased by liming. The legume ha
produced without lime on plots 10 to 13 averaged only 0.78 ton pe
acre for the 4 crops grown. With lime, the average was 1.26 to

an increase of nearly 62 per cent. The limed sections of the manured plots 6 and 7 gave an average yield of 46.7 bushels of corn per acre for the 5 crops of the corn years in rotation, as compared with 38.5 bushels from the unlimed sections. On plots 9 and 16, where corn was grown continuously without manure or legumes, the average yields per acre in the corn years were 31.0 bushels for the limed sections and 24.9 bushels for the unlimed. On plots 10 to 13, where the legumes were grown in alternate years, the average yield of corn on the limed sections was 44.8 bushels, and on the unlimed 35.5 bushels. The effect of liming was therefore almost equally marked under all of the experimental conditions, with an annual average increase of nearly 8 bushels per acre.

Inspection of the charts shows that during the 8-year period covered by the record there was little decrease in the effectiveness of the liming.

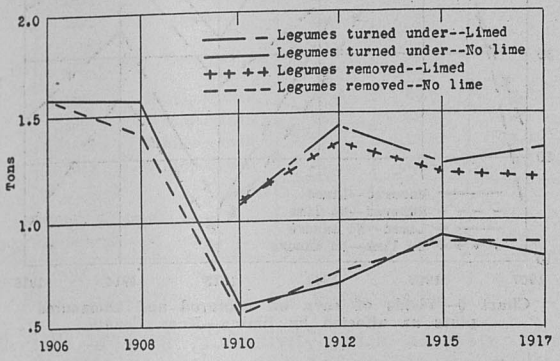

Chart 4—Yields of legume hay with and without liming—Knox County

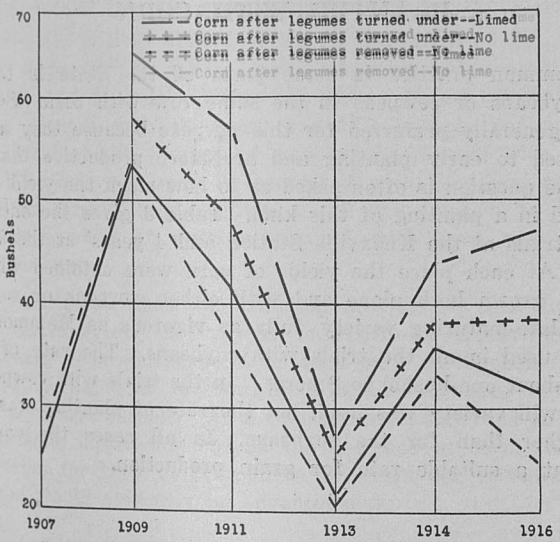

Chart 5—Yields of corn with and without liming—Knox County

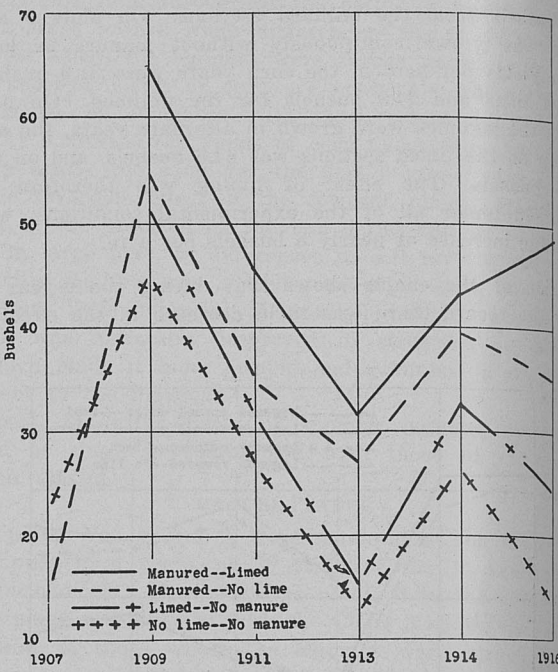

Chart 6—Yields of corn on manured and unmanured plots as affected by liming—Knox County

2. EFFECTS OF COWPEAS AND SOYBEANS PLANTED WITH CORN

PLANTED IN ROW WITH CORN

A common practice in some parts of the State is to p either soybeans or cowpeas in the same row with corn. Soybe are now generally preferred for this purpose because they are b ter adapted to early planting and are more productive than co peas. The question is often asked as to how much the yield of co is reduced in a planting of this kind. Table 3 gives the data fr 6 years' trials at the Knoxville Station and 4 years' at the Jack Station. At each place the yields of corn were obtained when t crop was grown both alone and with either cowpeas or soybea Tokio, a late-maturing variety, fully as vigorous as Mammoth Y low, was used in all the trials with soybeans. The rate of pla ing was about one bushel to 8 acres. In the trials with cowpeas Whippoorwill variety was used, but the rate of planting was s what higher than for the soybeans. In all cases the corn w planted at a suitable rate for grain production.

TABLE 3—*Yields obtained from corn and Tokio soybeans, each planted alone, and from mixtures of* (1) *corn and Tokio soybeans and* (2) *corn and Whippoorwill cowpeas*

Locality	Year	Variety	Yields per acre			
			Corn alone	Corn with beans or cowpeas		Beans alone
				Corn	Beans or peas	
			Bu.	Bu.	Bu.	Bu.
		Soybeans				
Knoxville	1915	Tokio	32.6	21.4	11.3	18.3
Knoxville	1916	Tokio	45.5	39.3	17.6	29.7
Jackson	1917	Tokio	68.0	49.8	6.7	17.6
Jackson	1919	Tokio	62.8	30.7	25.0	35.4
Jackson	1921	Tokio	51.8	29.3	31.5	36.1
Jackson	1922	Tokio	38.8	23.0	10.2	18.4
		Cowpeas				
Knoxville	1906	Whippoorwill	45.5	36.8	10.0	.....
Knoxville	1907	Whippoorwill	49.1	30.5	8.4	.....
Knoxville	1909	Whippoorwill	35.1	19.8	11.0	.....
Knoxville	1915	Whippoorwill	27.7	21.4	3.3	.....
Averages:						
Tokio soybeans—6 crops			49.9	32.3	17.1	25.9
Whippoorwill cowpeas—4 crops			39.4	27.1	8.2	.....

DISCUSSION OF THE DATA

With soils of good productivity, such as were used in the experiments, the moisture supply is frequently the limiting factor in crop production; hence, it is not surprising to find that both the soybeans and the cowpeas materially reduced the yields of the corn with which they were planted. The average yield of the 6 crops of corn grown with soybeans was 32.3 bushels per acre, whereas, under otherwise like conditions corn alone produced 49.9 bushels, or 17.6 bushels more to the acre. As an offset, the yield of beans planted with the corn was 17.1 bushels per acre. The average yield of the 4 crops of corn where planted with cowpeas was 27.1 bushels per acre, as compared with the average of 39.4 bushels for corn alone—a difference of 12.3 bushels to the acre. The average yield of cowpeas planted with corn was only 8.2 bushels per acre.

It is noticeable that the reduction in yield of corn due to the legume varies greatly from year to year. At Knoxville in 1916 the soybeans reduced the yield of corn only 6.2 bushels per acre. On the other hand, at Jackson, in 1919, the soybeans reduced the yield of corn 32.1 bushels. As a rule, however, the yield of soybeans nearly offsets, bushel for bushel, the decrease in corn. As a balanced ration for hogs or for soil-improvement the mixture of corn and beans would evidently be advantageous.

The question may be asked as to the value of a mixed c of corn and soybeans as compared with a crop from the same a one half planted to corn alone and the other half to soybeans al The data of table 3 show that as an average for the 6 years trial the mixed crop produced a total of 49.4 bushels per acre corn and soybeans, as compared with 37.9 bushels per acre wh the same crops were planted separately. The evidence is the fore highly favorable to the mixture, if only grain and seed pr duction are considered.

COWPEAS SOWN BROADCAST AT LAST CULTIVATION OF CORN

The last question for consideration is the effect of cowpe when sown broadcast at the last cultivation of corn—a not uncom mon practice in various parts of the State. To answer this que tion, data have been obtained for 17 years from 4 plots of rat 1 at the Jackson Station. Plots 14 and 15 were planted continuou to corn without cowpeas. Plots 16 and 17 were planted contin uously to corn, and Whippoorwill cowpeas were sown broadcast the rate of 1/2 bushel per acre at the last cultivation of the cor The average date of planting of the corn was April 26. The cow peas were generally sown the latter part of June. One plot of each set (Nos. 14 and 16) was manured every year at the rate of tons per acre. Plots 15 and 17 were unmanured. All the crop both grain and stover, were removed annually. The yields of cor under the various conditions are given in table 4 and are show graphically in chart 7.

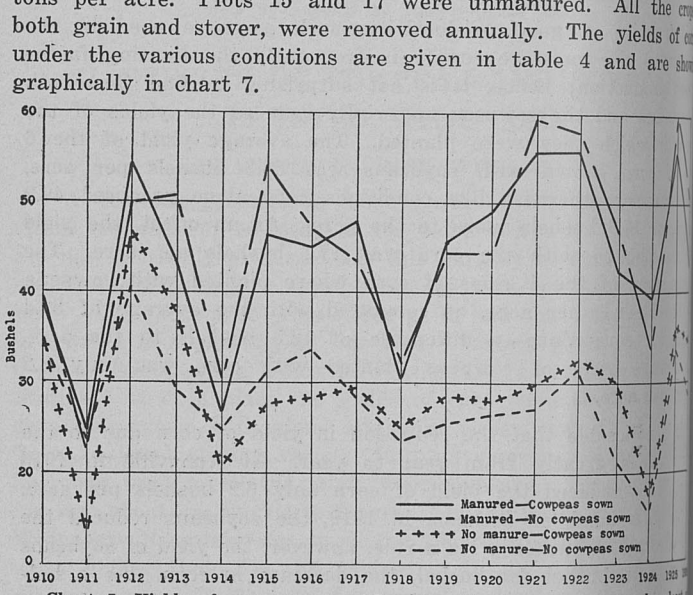

Chart 7—Yields of corn grown with and without cowpeas sown broadcast at the last cultivation—continuous experiments for 17 years under manured and unmanured conditions at the Jackson Station

TABLE 4—*Effect on the yield of corn produced by cowpeas sown broadcast at the last cultivation of the corn—continuous experiments for 17 years under both manured and unmanured conditions at the Jackson Station*

Year	Manure per acre	Plot	Yields of corn—no cowpeas grown		Plot	Yields of corn—cowpeas sown at last cultivation		Remarks
			Grain	Stover		Grain	Stover	
			Bu.	Tons		Bu.	Tons	
1910	5 tons	14	38.4	1.60	16	39.4	1.68	Light crop of cowpeas
	None	15	34.4	1.44	17	34.9	1.40	
1911	5 tons	14	25.0	1.08	16	22.9	1.10	Good crop of cowpeas
	None	15	23.9	0.90	17	13.2	0.78	
1912	5 tons	14	54.3	1.86	16	50.0	1.76	
	None	15	40.7	1.54	17	47.1	1.84	
1913	5 tons	14	43.2	1.30	16	50.7	1.34	
	None	15	29.2	0.92	17	37.8	1.00	
1914	5 tons	14	26.8	1.72	16	30.0	1.80	Cowpeas made little growth
	None	15	25.0	1.24	17	20.7	1.20	
1915	5 tons	14	46.4	1.42	16	53.9	1.54	Cowpeas made little growth
	None	15	31.0	0.80	17	27.8	0.74	
1916	5 tons	14	45.0	2.24	16	47.0	2.08	
	None	15	33.5	1.32	17	28.5	1.56	
1917	5 tons	14	47.9	2.20	16	43.6	1.82	
	None	15	28.2	1.24	17	29.3	1.38	
1918	5 tons	14	30.4	1.26	16	32.1	1.22	No stand of cowpeas obtained
	None	15	23.6	0.62	17	25.0	0.62	
1919	5 tons	14	45.7	1.62	16	44.3	1.71	No cowpeas sown—corn badly blown down
	None	15	25.4	0.78	17	28.2	0.82	
1920	5 tons	14	48.9	1.40	16	44.3	1.34	Cowpeas made very little growth
	None	15	26.4	0.76	17	27.9	0.76	
1921	5 tons	14	55.7	2.06	16	59.3	1.98	
	None	15	27.1	0.93	17	30.0	0.93	
1922	5 tons	14	55.7	1.58	16	57.9	1.53	
	None	15	31.4	0.96	17	32.5	0.96	
1923	5 tons	14	42.2	1.58	16	46.4	1.61	
	None	15	21.4	0.79	17	30.0	0.92	
1924	5 tons	14	39.3	1.92	16	33.7	1.94	Cowpeas a failure
	None	15	15.7	1.11	17	17.1	1.26	
1925	5 tons	14	55.7	1.44	16	60.0	1.74	Cowpeas made little growth
	None	15	33.6	0.76	17	36.1	0.96	
1926	5 tons	14	42.9	2.66	16	50.0	2.38	
	None	15	28.6	1.12	17	34.3	1.22	
Averages:								
Manured	17 yrs.		43.7	1.70	.....	45.0	1.68	
	Last 12 yrs.		46.3	1.78	.....	47.7	1.74	
Unmanured	17 yrs.		28.2	1.01	.....	29.4	1.08	
	Last 12 yrs.		27.2	0.93	.....	28.9	1.01	

DISCUSSION OF THE DATA

EFFECTS OF COWPEA CROPS ON YIELD OF CORN

The data are of special interest, both because of the suitab of the soil and manurial conditions to the objects in view, and cause of the duration of the experiments. As is well known in practice, the cowpea crop from a seeding in corn at the last cul tion is uncertain; that is, there are frequent failures. The re in this case shows that in 8 of the 17 years the cowpeas eit failed completely or made only a light growth. For 9 years the other hand, the growth may be described as good for a se ing of this kind. Occasionally an extra-good crop was obtained

The average acre yields of corn for the 17 years on manured plots were 43.7 bushels of grain and 1.70 tons of st where cowpeas were not grown, and 45.0 bushels of grain 1.68 tons of stover where cowpeas were grown. Without manu the average yields were 29.2 bushels of corn and 1.01 tons stover for the no-cowpea plots, and 29.4 bushels of corn and tons of stover for the cowpea plots.

Chart 7 gives no certain evidence of changing relationsh in the case of the manured plots, and the differences betw the yields on the two unmanured plots have remained nearly c stant for the last 10 years. Attention may be called to the f that even adjacent plots are seldom of exactly the same produ tivity. The effect on the yield of corn is therefore little in e dence, whether from the viewpoint of average yields or of tende for the period. Such a tendency as may be construed to exist favorable to the practice so far as the yield of corn is concern

MANURE VALUE

For the first 5 years yard manure of inferior value was us Beginning with 1915, or for the last 12 years, good-quality fa yard manure was applied regularly, and the data for this per are considered to give a fair index of its value. Manure, h ever, not only is of variable quality, depending on the kind of l stock, the feeding, and other factors, but the response is not t same under different soil conditions, some soils being decidedly m responsive than others. In this set of experiments the avera annual increase in yield of corn attributable to manuring for t last 12 years was 18.9 bushels per acre, or 3.8 bushels for e ton of manure used.

SUMMARY

EXPERIMENTS IN A COWPEA-CORN ROTATION

1. Experiments in a 2-year rotation of corn and cowpeas w carried out continuously for 20 years at the Knoxville Stati The main object was to determine the influence of the cowpea c on the yield of corn.

2. The yields of cowpea hay were well maintained through the period under all the experimental conditions. The average all plots was 1.28 tons per acre—a good average for the State.

3. The yields of corn showed a decidedly downward trend under all the experimental conditions, including the turning under of all cowpea crops.

4. The lowest average yield of corn, 27.1 bushels per acre, was obtained where the corn followed a bare fallow of the previous year. The average yield for the same years where corn was grown continuously was little better, being only 28.6 bushels.

5. The average yield of corn following the continued removal of the cowpea crops as hay was 34.0 bushels per acre, or 5.4 bushels more than the average for the same years where corn was grown continuously.

6. The highest average yield, 42.4 bushels per acre, was obtained where the cowpea crops were allowed to mature and were left every year on the surface of the ground throughout the winter.

7. The next highest yield, 40.8 bushels per acre, was obtained where the cowpea crops were turned under every fall.

8. The difference in favor of the turning under of the cowpea crop in the spring was not noticeable until after the sixth corn crop, but averaged 6 bushels per acre for the 4 crops thereafter.

9. A similar series of experiments was carried out for 12 years on a poorer type of soil located about six miles south of Knoxville. In this series data were obtained for 8 years under both limed and unlimed conditions. Also experiments with farmyard manure were included.

10. Both cowpeas and soybeans were grown in alternation with corn. The average yield of hay for all plots and conditions was 1.20 tons per acre for the 6 crops grown.

11. The last 4 crops of legumes were grown both with and without lime. Without lime the average was 0.78 ton per acre; with lime the average was 1.27 tons, an increase of 0.49 ton, or nearly 63 per cent.

12. Where corn was grown continuously the average yield was 27.1 bushels per acre.

13. With the legumes removed as hay, the average yield of corn following was 35.5 bushels per acre—a gain of 8.4 bushels over the yield for continuous corn for the same years. This marked increase is attributed in part to the evident loosening and granulating effect of the cowpea and soybean crops on this soil, which was of a somewhat heavy, close type.

14. Where the legumes were turned under the average yield of corn per acre was 39.7 bushels, which was only 4.2 bushels larger than where the hay crops were removed.

15. Manure was applied to 2 plots at the rate of 6 tons per acre every other year. The average yield was 38.0 bushels per acre, lacking only 1.7 bushels of being equal to that obtained where the legume crops were turned under.

16. With the 11 crops of corn taken into consideration, the average increase in yield per ton of manure was 4.77 bushels.

17. Liming greatly increased the corn crops every year under all conditions. Under manuring the average increase from lime was 8.2 bushels per acre; without manure, and corn grown continuously, the average increase was 6.1 bushels; and where legumes were grown the average increase was 9.3 bushels.

18. No diminution in the effectiveness of the liming was evident, although only a single application of 2 tons of ground limestone per acre was made.

19. General conclusions: It is unprofitable to turn under a cowpea or soybean crop for the sake of increasing the productiveness of the soil as measured by the corn crop of the following year. It is evident, however, that a much better than average condition may be expected where the legumes are pastured off or are fed and the manure returned. Even when the summer legume is removed as hay a larger corn crop may be expected than where corn follows corn, but the effect is small in comparison with the soil effects of such legumes as red clover and alfalfa.

EFFECTS OF COWPEAS AND SOYBEANS PLANTED WITH CORN

1. Experiments were carried out for 6 years with soybeans and for 4 years with cowpeas to determine the effects of these crops when planted in the row with the corn, a not uncommon practice. In every case the yields of corn were greatly reduced, the average reduction for the 10 years' trial being 15.5 bushels per acre.

2. The average yield of soybeans when planted with corn was 17.1 bushels per acre, but that of cowpeas was only 7.5 bushels.

3. The average yield of 6 crops of soybeans planted alone was 25.9 bushels per acre. The reduction in yield when the soybeans were planted with corn was 8.8 bushels, or 34 per cent.

4. The mixed crop of corn and Tokio soybeans produced, as a 6-year average, 49.9 bushels of grain and seed per acre, as compared with an average of only 37.9 bushels per acre when the 2 crops were planted separately on equal areas.

5. The practice of planting soybeans with the corn is considered advantageous from the point of view of soil production and the increased value of the crop for "hogging-off" purposes.

6. In 8 out of 17 years of trial at the Jackson Station cowpeas sown broadcast in corn at the last cultivation either failed completely or made only a light and unprofitable crop. This was true both with and without an annual application of 5 tons per acre of farmyard manure.

7. There was no indication under either the manured or unmanured condition that the yields of corn were reduced by a seed crop of this kind.

8. With the results of the last 12 years at the Jackson Station taken as the more reliable guide, each ton of manure produced, on the average, an increase of 3.8 bushels of corn and 400 pounds of stover per acre.